

## CLAIMS

1. A two dimensional photonic crystal sensor apparatus comprising:  
a waveguide for inputting light; and  
5 a photonic crystal slab optically coupled to said waveguide, said photonic crystal slab comprising a two dimensional periodic lattice of holes, said two dimensional periodic lattice of holes comprising a lattice constant and a defect hole, said photonic crystal slab operable to receive said light from said waveguide and operable to confine said light in said defect hole at an  
10 operating wavelength.
2. The apparatus of Claim 1 wherein said defect hole has a larger volume than said holes.
- 15 3. The apparatus of Claim 1 wherein said defect hole has a smaller volume than said holes.
4. The apparatus of Claim 1 wherein said photonic crystal slab is comprised of silicon.
- 20 5. The apparatus of Claim 1 wherein said two dimensional periodic lattice is a triangular lattice.

6. The apparatus of Claim 1 wherein said defect hole has a substantially elliptical cross-section.
7. The apparatus of Claim 1 wherein said photonic crystal sensor is operable to outcouple light from said photonic crystal slab in a direction perpendicular to said photonic crystal slab.
8. The apparatus of Claim 1 further comprising a tunable optical source coupled top said waveguide.
9. The apparatus of Claim 1 wherein said waveguide is a conventional ridge waveguide.
10. The apparatus of Claim 1 wherein an operating wavelength of said photonic crystal sensor is determined by a dither system.
11. The apparatus of Claim 1 wherein an operating wavelength of said photonic crystal sensor is determined by a synchronized scanning system.
12. The apparatus of Claim 1 wherein an operating wavelength of said photonic crystal sensor is determined by a using system of multiple light emitting diodes.

13. The apparatus of Claim 1 wherein an operating wavelength of said photonic crystal sensor is determined by using a slope based detection system.

5 14. The apparatus of Claim 1 wherein a photodetector is positioned out of the plane of said photonic crystal slab to be operable to detect said light at an operational wavelength of said photonic crystal sensor.

10 15. A two dimensional photonic crystal sensor apparatus comprising:  
a photonic crystal slab comprising a two dimensional periodic lattice of holes with a lattice constant and a plurality of defect holes, said photonic crystal slab operable to confine light at a plurality of operating wavelengths to said plurality of defect holes; and  
a substantially straight line of defects defining a waveguide in said two  
15 dimensional periodic lattice of holes, said waveguide optically coupling to said plurality of defect holes.

20 16. The apparatus of Claim 14:said plurality of defect holes do not all have the same volume.

25 17. The apparatus of Claim 14 wherein said plurality of defect holes are arranged in an order to maximize the optical coupling of said waveguide to said plurality of defect holes.

18. A two dimensional photonic crystal sensor apparatus comprising:  
a plurality of input waveguides; and  
a photonic crystal slab optically coupled to each of said plurality of  
waveguides, said photonic crystal slab comprising a two dimensional periodic  
5 lattice of holes with a lattice constant and a plurality of defect holes, said  
photonic crystal slab operable to receive light from said plurality of  
waveguides and operable to confine said light at a plurality of operating  
wavelengths in said plurality of defect holes.
- 10 19. The apparatus of Claim 17 wherein said plurality of input waveguides is  
optically addressed using a diffractive array generator.
20. The apparatus of Claim 17 wherein said plurality of input waveguides is  
optically addressed using a dynamically reconfigurable diffractive array  
15 generator.
21. The apparatus of Claim 17 wherein said plurality of input waveguides is  
optically addressed using a MEMs based dynamically reconfigurable  
mirror array.
- 20 22. A three dimensional photonic crystal sensor comprising:  
an input waveguide; and  
a three dimensional photonic crystal lattice structure optically coupled to  
said waveguide, said three dimensional photonic crystal lattice structure  
25 having a defect region, said three dimensional photonic crystal lattice

structure operable to receive light from said input waveguide and operable to confine said light at an operating wavelength in said defect region.

23. The apparatus of Claim 22 further comprising an output waveguide  
5 operable for outcoupling said light at said operating wavelength from said three dimensional photonic crystal lattice structure.

24. A photonic crystal sensor apparatus comprising:  
a waveguide for inputting; and  
10 a photonic crystal structure optically coupled to said waveguide, said photonic crystal structure comprising a lattice, said lattice comprising a lattice constant and a lattice defect, said photonic crystal structure operable to receive light from said waveguide and operable to confine said light in said lattice defect at an operating wavelength.

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